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(71) Applicant *(for all designated States except US)*: **R.P. SCHERER TECHNOLOGIES, INC.** [US/US]; Suite 260, 2030 East Flamingo Road, Paradise Valley, NV 89119 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **STOLZ, Frederick, R.** [US/US]; 300 Tralee Street, Largo, FL 33770 (US).

(74) Agents: **ROZYCKI, Andrew, G.** et al.; Cardinal Health, Inc., 7000 Cardinal Place, Dublin, OH 43017 (US).

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(54) Title: EMULSION OF WATER SOLUBLE DYES IN A LIPOPHILIC CARRIER

(57) Abstract: The invention herein provides for an improved dye composition for encapsulation in casing structures adapted for projectile motion and rupture upon contact with a target surface, such as paint balls. The dye composition adapted for use in an impact-rupturable capsule of the invention comprises a water-soluble dye and a lipophilic carrier having an oil and an emulsifier, said emulsifier comprising ethoxylated mono-and diglycerides. The invention further provides for an impact-rupturable capsule containing the dye composition. Advantages of the dye composition of the invention include improved consistency and reduced separation of ingredients; greater viscosity and thickness; greater "smearability" and splattering of dye on target surface upon impact and rupture of the casing; and greater water solubility an improved machine washability.

EMULSION OF WATER SOLUBLE DYES IN A LIPOPHILIC CARRIER

Inventor: Frederick R. Stolz

Field of the Invention

The invention relates to dye formulations for containment in impact-rupturable projectile capsules and for dispersing on impact with a surface. In particular, the invention pertains to dye compositions used in paint balls and in conjunction with paint ball firing devices in the sports and leisure fields, for example.

Background of the Invention

Soft and hard capsules or casings have been employed in the pharmaceutical field to encapsulate a variety of therapeutic and nutritional liquid compositions. Similar technology has been employed in the sports and leisure fields to contain dye formulations within capsules adapted to rupture upon impact with an intended target. Liquid dye compositions encapsulated within gelatin casings, collectively and commonly known as "paint balls," are designed for use in conjunction with a projectile device, such as a "paint ball gun". Generally, such dye capsules have the physical properties in which the casing is hard and impact resistant enough to survive high velocity projectile forces, while at the same time adapted to rupture and release the dye composition upon high velocity contact with the target surface. "Paintball" is now a recognized and popular sporting activity, played by thousands of men and women throughout this country, as well as thirty other countries worldwide.

When employed in competitive activities wherein the objective of said activity is to identify the accuracy of marking the intended target, it is desirable to optimize

the visual results of a successful contact with the intended target. Dye compositions used in paint balls are available in a wide variety of bright colors. The particular color can be used, for example, to identify the source of the paint ball after firing. In addition to a clearly visible coloration applied to the surface of the target, the effects can also be enhanced by the dispersing or "splatter" capabilities of the dye composition upon rupturing of the casing. These visual objectives must, however, be balanced in conjunction with certain physical parameters, such as cleaning from fabrics, overall weight and the ability for the liquid dye composition to be contained for a prolonged period of time within the casing material without substantive degradation. Furthermore, regulatory concerns must be addressed as well, such as toxicity of ingredients.

Some currently available dye compositions used in paint balls contain a dye in conjunction with hydrophilic carriers containing a mixture of high and low molecular weight polyethylene glycols (PEG). Among the disadvantages associated with currently available dye compositions include tenacious or permanent staining of target fabrics, freezing and solidification of the dye composition during exposure to colder temperatures, and separation and precipitation of dye composition ingredients during storage, and a thin consistency.

There exists a need in the field of sports and leisure, as well as the zoological field, for improved technology relating to impact-rupturable capsules containing dye formulations. In particular, there is a need to improve the desirable attributes of

impact-rupturable dye capsules by enhancing the properties of the dye formulations within.

Summary of the Invention

The invention provides for an improved liquid dye composition for encapsulation in casing structures adapted for intact projectile motion and rupture upon contact with a target surface. In particular, the dye composition of the invention is useful in paint balls for use in conjunction with projectile devices, such as paint ball guns. The dye composition of the invention is also useful in the zoological and wildlife preservation fields, such as "tagging" animals without substantive injury or the need for sedation in order to aid in tracking their movements through the environment. It has been discovered that the use of certain types of emulsifiers in conjunction with certain other specific types of ingredients produce a liquid dye composition having a unique combination of desirable properties associated with the impact-rupturable capsules. More particularly, it has been discovered that dye formulations can be prepared which have the advantages of: i) improved consistency and reduced separation of ingredients; ii) greater viscosity and thickness; iii) greater "smearability" and splattering of dye on the target surface upon impact and rupture of the casing; iv) greater water solubility and improved machine washability; and v) greater ability to regulate weight of the capsule (up to 3.5g limit).

The invention provides for a liquid dye composition adapted for use in an impact-rupturable capsule comprising a water-soluble dye and a lipophilic carrier

having an oil and an emulsifier, said emulsifier comprising ethoxylated mono- and diglycerides.

The invention further provides for an impact-rupturable capsule comprising:

a casing adapted to contain a liquid dye composition, to remain intact upon exertion of projectile forces sufficient to propel said casing, and to rupture upon impact with a solid or semi-solid surface and release said liquid composition; and

a liquid dye composition comprising a water-soluble dye and a lipophilic carrier having an oil and an emulsifier, said emulsifier comprising ethoxylated mono- and diglycerides.

Brief Description of the Drawings

Figure 1 is a photograph showing a comparison between the marking characteristics of the dye composition according to one embodiment of the invention and an existing dye composition as applied to a target surface.

Figures 2A and **2B** are before and after photographs showing the washability of a currently commercially available dye composition as applied to fabric.

Figures 3A and **3B** are before and after photographs showing the washability of the dye composition according to one embodiment of the invention as applied to fabric.

Detailed Description of the Invention

As used herein, the phrase "impact-rupturable capsule" is meant to describe a capsule containing a liquid or semi-solid component therein, said capsule adapted to rupture upon impact with a solid or semi-solid surface.

As used herein, the term "paint ball" is meant to describe the commonly known combination of a liquid dye composition encased within a capsular structure and which is adapted for projectile motion. Although the term "ball" conventionally implies a spherical shape, the term as applied to the encapsulated dye composition described herein is not intended to be limiting to a spherical shape within the context of this invention.

The term "paint ball gun" and "paint ball marker" are meant to synonymously refer to the devices typically associated with the firing of paint balls.

The term "target" is meant to refer to the solid or semi-solid object upon which the application of the dye composition is intended. Such objects can be living, such as human or other animals, or non-living, such as inanimate or moving surfaces and structures. The terms "solid" and "semi-solid" when used in reference to a target surface are meant to describe the physical property of a surface which provides an opposing force sufficient to resist penetration by the impact-rupturable capsule when propelled onto the surface.

The term "liquid" when used to describe the dye composition of the invention, is meant to include any non-solid physical state of the composition capable of

dispersing or spreading onto a given surface, i.e., in both its highly flowable state as well as semi-solid viscous and "smearable" state.

The dye composition of the invention is an emulsion containing a water-soluble dye in a lipophilic carrier. More specifically, the liquid dye composition of the invention is an emulsion comprising a water-soluble dye, an oil, and an emulsifier comprising ethoxylated mono- and diglycerides. Additional ingredients which can be used include, but are not limited to, thickeners, opacifiers, and density agents.

Aqueous or water-soluble dyes which can be used in the invention include, but are not limited to, FD&C Yellow #5 (available from BF Goodrich Hilton Davis Chemical Company, Brecksville, OH), FD&C Yellow #6 (available from BF Goodrich Hilton Davis Chemical Company) D&C Yellow #10 (available from Warner Jenkinson, St. Louis, MO), FD&C Blue #1 (available from BF Goodrich Hilton Davis Chemical Company), D&C Red #28 (available from Warner Jenkinson), D&C Red #33 (available from Warner Jenkinson), Magenta Dispersion (available from Warner Jenkinson), Green Dispersion (available from Colorcon, West Point, PA), and Yellow Dispersion (available from Colorcon).

The aqueous water-soluble dye can be present in an amount sufficient to afford the composition with apparent coloration. The dye can be present in an amount ranging from about 1% to about 10% by weight of the total composition. Preferably, the dye is present in an amount of about 5% by weight of the total composition.

A variety of colors can be used as the dye ingredient of the inventive composition. The liquid dye composition can be colored red, magenta, pink, yellow,

blue, orange, purple, violet, green, and the like. Typically, highly visible colors are used, including fluorescent versions of the colors.

Oils used in accordance with the invention can include vegetable oils. Suitable vegetable oils include, but are not limited to, soybean oil, sunflower oil, corn oil, safflower oil, and the like. In a preferred embodiment, soybean oil is used.

The oil can be present in an amount ranging from about 35% to about 95% by weight of the total composition. Typically, the oil is present in an amount ranging from about 50% to about 85% by weight of the total composition. Preferably, the oil is present in an amount of about 79.5% by weight of the total composition.

Emulsifiers comprising ethoxylated mono- and diglycerides which can be used include those comprising mixtures of mono- and diglycerides and ethoxylated mono- and diglycerides. One example of a preferred emulsifier is Tally 100K PLUS™, which comprises a blend of mono- and diglycerides and ethoxylated mono- and diglycerides (commercially available from Loders Croklaan USA, Glen Ellyn, IL). The weight ratio of ethoxylated mono- and diglycerides to mono- and diglycerides in the mixture can range from about 1:10 to about 10:1.

The emulsifier can be present in an amount sufficient to provide a stable emulsion in accordance with expected storage and usage temperatures. Preferably, the emulsifier can be present in the dye composition in an amount ranging from about 2.5% to about 25% by weight of the composition, preferably in a range of from about 5% to about 15% by weight of the composition. More preferably, the emulsifier is present in an amount of about 12.5% by weight of the total composition.

Thickeners can be added to the composition to modify the texture and viscosity of the composition, and at least one thickener is preferred in the composition. Suitable thickeners include, but are not limited to, wax thickeners and silica thickeners. Suitable wax thickeners include beeswax and paraffin wax (available from Strahl & Pitsch, Inc., West Babylon, NY). Wax thickeners can be present in an amount up to 10% by weight of the total composition, more typically up to about 5% by weight. Preferably, the wax thickener is present in an amount of about 2% by weight of the total composition.

Suitable silica thickeners include, but are not limited to, SiO_2 compositions. Suitable SiO_2 compositions include Cabosil™ (commercially available from Cabot Corporation, Edison, NJ) and HDKN-20 (commercially available from Wacker, King of Prussia, PA). Silica thickeners can be present in an amount of up to 3% by weight of the total composition, typically from about 0.25% to about 2.0% by weight of the total composition. Preferably, the silica thickener is present in an amount of about 1.0% by weight of the total composition.

In a preferred embodiment, a combination of both a wax thickener and a silica thickener is used in the composition. When the thickener combination is used, the thickeners are present in combination in an amount of 13% by weight or less of the total composition. Generally, the relative amounts and proportions of the thickeners will vary according to the viscosity properties desired.

To increase the density of the inventive composition to a level suitable for use in a firing device, density agents can be added. One example of a density agent is

tricalcium carbonate, or Ca_3CO_3. Other density agents which can be used include, but are not limited to, tricalcium phosphate, dicalcium phosphate, zinc gluconate, zinc sulfate, zinc oxide, and zinc citrate. Mixtures of density agents can be used as well.

The density agent can be present in an amount sufficient to assist in the rupture of the filled capsule upon impact with a target surface. Typically, the density agent can be present in an amount up to about 50% by weight of the total composition, more typically in an amount ranging from about 10% by weight to about 35% by weight of the total composition. Preferably, the density agent is present in an amount of about 25% by weight of the total composition.

Additional ingredients can be used in accordance with the invention, provided the inventive attributes of the composition are maintained. Secondary ingredients, such as opacifiers and the like, can be added to the composition.

The dye composition of the invention can be prepared by the following general process. An initial mixture can be prepared by adding a thickener, such as SiO_2 (e.g., Cabosil™) to a vegetable oil, such as soybean oil. This initial mixture is set aside to be used later in the process. An additional amount of the vegetable oil (e.g., soybean oil) is heated while stirring, followed by the slow addition of the emulsifier (e.g., Tally 100 PLUS™) and additional thickener (e.g., yellow wax) to the oil. The resulting mixture containing the oil, emulsifier and wax is then mixed until the ingredients are completely dissolved at a temperature of about 145° F. While continually stirring, the initial mixture containing the oil and SiO_2 is combined with the oil, emulsifier and wax, and the entire composition is stirred until a uniform

consistency is produced. The temperature is allowed to reduce. Once the temperature reduces to about 80° F or less, the color dispersion is added and the composition is mixed until uniform and for a time period of at least about 30 minutes. The resulting composition is in a flowable state immediately after the process. After setting over time, the composition sets into a semi-solid state with no observable separation.

Using this process, the following batch of liquid dye composition was prepared by adding the following ingredients and respective amounts as set forth below:

Formula 1: Dye Composition containing Ethoxylated Emulsifier

Ingredient:	**Amt. (kg):**	**Amt. (%w/w):**
Soybean Oil (part 1)	276.00	30.00
Wax (thickener)	18.40	2.00
Tally™ 100 PLUS (emulsifier)	115.00	12.50
Silicon dioxide (thickener)	9.20	1.00
Soybean Oil (part 2)	455.40	49.50
Color dispersion	46.00	5.00
Total:	920.00	100.00

The casing material used in the impact-rupturable capsule of the invention can be any conventional material which can be formed into a capsule and adapted to encapsulate liquid contents while permitting rupture of the casing upon exertion of physical force thereon. Preferably, the casing material has chemical properties compatible with the composition contained thereby and physical properties sufficient to resist exertion of a projectile force while insufficient to resist impact forces following high airborne velocities. Even more preferred are casing materials which

can be formed into an elastic ribbons or sheets to be filled with liquid and are suitable for heat or solvent sealing consistent with conventional die roll encapsulation manufacturing techniques. Additional suitable casing materials include, but are not limited to, gelatin, PVC, celluloses, modified starches, carrageenans, gums, pectins, alginates, and the like. Those skilled in the encapsulation arts will readily be able to select the appropriate casing material based upon the composition of the fill and the equipment used to perform the encapsulation. Generally, the casing material used for the capsule is any material usually used for the shell of a soft capsules. An example of a useful casing material is one consisting primarily if gelatin and further containing a plasticizer, pigment, solubility adjusting agent, and the like.

The overall shape of the capsule and casing can vary. Preferably, the shape of the capsule permits substantially linear movement through air when fired by a paint ball gun. Most preferably, the shape of the capsule is spherical. The diameter of the capsule can vary but is preferably compatible with the firing device with which it is to be used. For example, a .68 caliber spherical capsule can be used with commercially available paint ball guns.

The exterior appearance of the casing material and capsule can vary as well. A variety of visual designs and exterior coloration alternatives are possible. As with the dye formulation, a wide variety of colors can be used for the casing material either integrally or on the exterior surface alone. Lines, stripes, spots, marbled, two-tone designs can be used, for example. Various patterns can be applied to the surface of

the capsules using the technique described in Brox et al., U.S. Patent No. 5,529,767, the entire text of which is incorporated herein by reference.

The impact-rupturable capsules of the invention can be prepared using conventional techniques and apparatuses. Generally, with some modifications, the apparatuses used to prepare soft gelatin capsules in the pharmaceutical field can be used to manufacture impact-rupturable capsules. One example of a suitable apparatus is described in Stroud et al. U.S. Patent No. 5,735,105, the entire text of which is incorporated herein by reference. This patent describes an apparatus and method for preparing liquid-filled capsules using a die roll apparatus through which a casing material in the form of a ribbon or sheet is fed.

The impact-rupturable capsules containing the dye composition of the invention are set into projectile motion with the casing substantially intact at a velocity sufficient to create the force permitting rupture of the casing and release of the liquid dye composition therein upon physical impact with the target surface. Typically, the suitable velocity range is from about 200 ft/sec to about 400 ft/sec, preferably within a range from about 300 ft/sec to about 350 ft/sec. Such devices are typically in the form of a gun assembly adapted for use with the capsules. The gun assembly is commonly referred to as a paint ball gun or "marker." Suitable paint ball guns include commercially available models such as those from Pursuit Marketing, Inc. (PMI) (Schiller Park, IL). Accordingly in use, the impact-rupturable capsule is removed from a container and loaded into the paint ball gun. The gun is aimed at the intended target and fired, ejecting the impact-rupturable capsule substantially intact at

high speed toward the target through the use of pressurized CO_2 or N_2. Upon impact on the target surface, the casing ruptures thereby releasing the liquid contents within onto the surface. The appearance of the liquid contents on the surface material is readily apparent by the observer.

EXAMPLES

Two liquid dye formulations were obtained and compared for appearance and washability. The dye formulations were identified as the currently available "old" formulation, and the "new" formulation in accordance with the invention. The respective formulations are set forth below:

Old Formulation:

Ingredient:	Amount (%w/w):
PEG 300 (hydrophilic carrier)	85.02
Glycerin	2.99
Rheolate™ 5000 (thickener)	3.30
Ethomeen™ (pH adjuster)	0.70
Water	2.99
Color	5.00
Total:	**100.00**

New Formulation:

Ingredient:	Amount (% w/w):
Soybean oil (lipophilic carrier)	79.50
Tally 100 (emulsifier)	12.50
SiO_2 (thickener)	1.00
Wax (thickener)	2.00
Color	5.00
Total:	**100.00**

Referring now to the Figures, a visible comparison between the marking characteristics of the dye composition according to one embodiment of the invention and an existing dye composition as applied to a target surface can be seen in Figure 1. The dye composition of the invention identified as the "new formula" corresponds to the invention. As can be seen, the old formula shows extensive "running" after rupture, whereas the composition of the invention is thicker and substantially retains the relatively confined spread or "splatter" following impact.

Washability experiments were performed using the old formula and the dye composition of the invention and compared. Impact-rupturable capsules were fired onto white T-shirts from a distance of 50 feet. The excess material was wiped away from the shirts. The shirts were allowed to stand for a period of 72 hours and then washed in a conventional washing machine using a warm water wash and cold water rinse. The old formula, as shown in Figures 2A and 2B, exhibit significant staining in comparison to the dye composition of the invention as shown in Figures 3A and 3B. Accordingly, the dye composition of the invention has improved washability and water-solubility when applied to fabric.

Industrial Applicability:

The dye composition of the invention is useful in capsular structures designed for projectile motion and rupture upon impact with a target surface. Such uses include those associated with paint ball gaming activities, as well as other contexts of marking of objects. Typically, the impact-rupturable capsules of the invention are set into motion by a firing device, such as a paint ball gun.

The invention has been described with reference to various specific and preferred embodiments and techniques. It will be understood, however, that reasonable modifications of such embodiments and techniques can be made while remaining within the spirit and scope of the invention.

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CLAIMS

What is claimed is:

1. A liquid dye composition adapted for use in an impact-rupturable capsule comprising a water-soluble dye and a lipophilic carrier having an oil and an emulsifier, said emulsifier comprising ethoxylated mono- and diglycerides.
2. The liquid dye composition according to claim 1 wherein the impact-rupturable capsule is spherical in shape.
3. The liquid dye composition according to claim 1 wherein the oil is a vegetable oil.
4. The liquid dye composition according to claim 3 wherein the oil is soybean oil.
5. The liquid dye composition according to claim 1 wherein the emulsifier comprises a mixture of ethoxylated mono- and diglycerides and mono- and diglycerides.
6. The liquid dye composition according to claim 5 wherein the emulsifier comprises a mixture of ethoxylated mono- and diglycerides to mono- and diglycerides in a weight ratio ranging from about 1:10 to about 10:1.
7. The liquid dye composition according to claim 1 wherein the emulsifier is present in an amount ranging from about 2.5% to about 25% by weight of the total composition.

8. The liquid dye composition according to claim 7 wherein the emulsifier is present in an amount ranging from about 5% to about 15% by weight of the total composition.

9. The liquid dye composition according to claim 1 further comprising at least one thickener.

10. The liquid dye composition according to claim 9 wherein the thickener comprises wax.

11. The liquid dye composition according to claim 9 wherein the thickener comprises silica.

12. The liquid dye composition according to claim 9 wherein the thickener is a combination of wax and silica.

13. The liquid dye composition according to claim 1 further comprising a density agent.

14. The liquid dye composition according to claim 12 wherein the density agent is tricalcium carbonate, tricalcium phosphate, dicalcium phosphate, zinc gluconate, zinc sulfate, zinc oxide, and zinc citrate, or mixtures thereof.

15. A liquid dye composition adapted for use in an impact-rupturable capsule comprising a water-soluble dye and a lipophilic carrier, said lipophilic carrier comprising:

a vegetable oil;

an emulsifier comprising ethoxylated mono- and diglycerides; and

a thickener.

16. An impact-rupturable capsule comprising:

a casing adapted to contain a liquid dye composition, to remain intact upon exertion of projectile forces sufficient to propel said casing, and to rupture upon impact with a solid or semi-solid surface and release said liquid composition; and

wherein said liquid dye composition comprises a water-soluble dye and a lipophilic carrier having an oil and an emulsifier, said emulsifier comprising ethoxylated mono- and diglycerides.

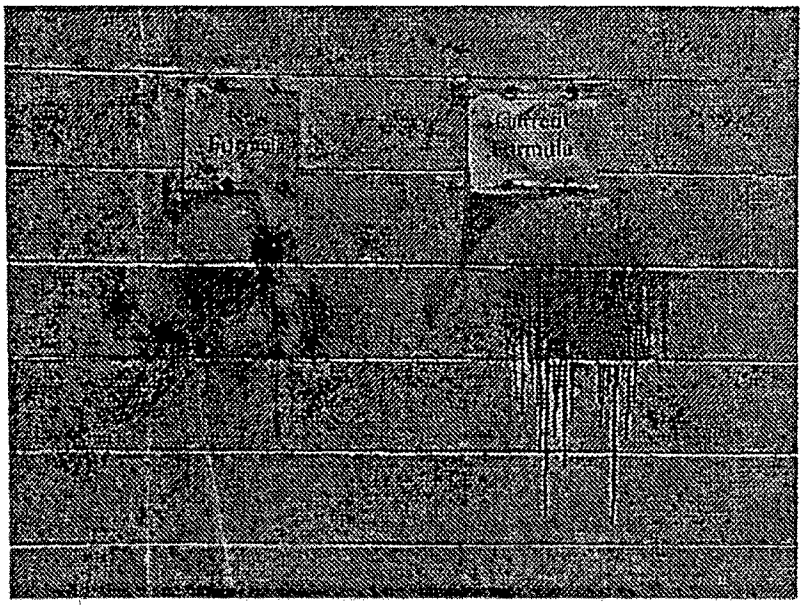

FIG. 1

FIG. 2A

FIG. 2B

FIG. 3A

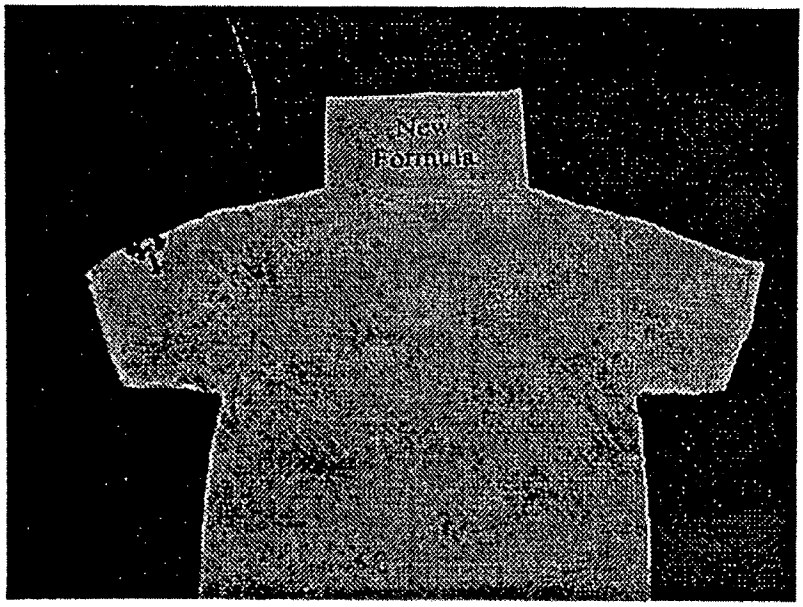

FIG. 3B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/28361

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : D06P 1/39; F42B 8/14, 12/74; C09B 67/24
US CL : 8/576, 580, 673, 680; 102/502

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 8/576, 580, 673, 680; 102/502

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WEST: EAST CAS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passage	Relevant to claim No.
A	US 5,494,938 A (Kawa et al.) 27 February 1996 (27.02.1996) see abstract	1-15
A	US 4,656,092 A (Haman et al.) 07 April 1987 (07.04.1987)See abstract and examples in col 3 lines 45-67	1-16
A	US 5,254,379 A (Kotsiopoulos et al.) 19 October 1993(19.10. 1993) see abstract	16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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Date of mailing of the international search report
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Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703)305-3230

Authorized officer
Margaret Einsmann
Jean Proctor
Paralegal
Telephone No. 703-308-0661

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